

Center of Population Calculation for the City of Bloomington, Indiana

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Introduction

The United States Census Bureau calculates the centers of population for counties in the United States, each of the fifty states, the District of Columbia, and for the nation. This document provides the method used by the City of Bloomington ITS Department's GIS Group to calculate the center of population for Bloomington, Indiana. The method is adapted from that used by the U. S. Census Bureau and any differences between the two methods will be discussed herein.

Conceptually speaking, the center of population can be thought of as a balance point. The conceptual model used by the Census Bureau as well as the one used here is to think of the center of population as the point at which an imaginary, rigid, flat, and weightless representation of a surface (in this case Bloomington) would balance if weights of identical size were placed on it so that each weight represents the location of one person. The term "center of population" is also used to describe the median population location where 50% of a population falls east of a north/south line and 50% falls west of that line, while an east/west line divides the population where 50% falls north of the line and 50% falls south of that line. The point at which these lines intersect is the median population location. The center of population described in this document can be thought of more appropriately as a mean population location.

As an historical note, Bloomington, Indiana served as the center of population for the United States in 1910. According to the Census Bureau, the center of population for the nation was located in the state of Indiana for six decades between the years of 1890 and 1940, the longest of any state. During this time, the center drifted in a generally southwesterly direction until, when in 1950, it was determined that the nation's center of population had moved into Illinois.

Method Used for Calculating the Center of Population for Bloomington, Indiana

The mathematical formulae used to calculate the center of population is rather straightforward. Thus, much of this discussion pertains to the preparation of the spatial data used in the calculation. The center of population was calculated using data collected during the 2000 decennial census. Enumeration units known as census blocks represent the smallest unit of area for which the population is known. While the population within a block is known, the distribution of the population within it is not. Census blocks vary in area and population count. The vast majority of census blocks used in this calculation do fall entirely within the municipal boundary of Bloomington. However, an issue does exist where census block boundaries do not coincide with the municipal boundary. In these situations, a portion of the population within such census blocks can fall inside the city while a portion of the population within such blocks can fall outside the city.

One way in which this issue can be resolved is by truncating the census block at the municipal boundary, essentially creating two 'new' blocks that are separated by the municipal boundary. The 'new' block that is not within the city is then discarded and the population of the 'new' block within the city is estimated in proportion to the area of the retained portion of the original block. For example, if the retained portion of the original block (that portion that falls within the municipal boundary) is one third of the area of the original block, then the population assigned to the retained portion of the block is estimated at one third of the population that was assigned to the original block. The obvious point here is that population is assumed to be distributed equally throughout census blocks.

A second technique that can be employed to resolve this issue is to omit any census blocks that do not fall entirely within the municipal boundary. There are some disadvantages to such a technique. First, while this simplifies the methodology, it would also lead to an understatement of the overall population. Second, it could also impact the calculated location of the center of population.

A third technique, and the one implemented here, is to include any and all census blocks the fall entirely within or cross the municipal boundary. While this technique simplifies the preparation of the spatial data, it leads to a slightly overstated population for Bloomington. It may also lead to a slight shift in the calculated center of population. While it is assumed for the calculation that population is equally distributed within each census block, in reality it is not. It is more likely that population density decreases as distance increases outward from the municipal boundary. Thus, the rationale for retaining census blocks that extend beyond the municipal boundary is that the error of commission (overstatement of population) is less than the error of omission (understatement of population) that would occur if those census blocks were excluded.

Because census blocks are the smallest unit of area for which the population is known and because, as mentioned previously, it is assumed that population is evenly distributed within each census block, the geographic center of each block can also serve as the population center for each block. The geographic center of a census block is the point at which the surface of the block would balance if it were a plane of uniform weight per unit of area. Geographic information system software was used to calculate the geographic centers for all Bloomington census blocks, creating a single geographic center point for each block. This technique of using the geographic center as a representation of the population center of each block is not dissimilar to the technique used by the U.S. Census Bureau. Population counts and x, y coordinates were then associated with each point. There are a total of 1264 points representing Bloomington's population. Points that had a population count of 0 were discarded leaving 955 points. It is these remaining points and their associated population counts and x, y coordinates that were used in calculating Bloomington's center of population.

The U.S. Census Bureau calculates the center of population for small scale (but think large) areas such as states and the nation itself. This makes calculating the center of population in latitude (y) and longitude (x) appropriate. Because the earth approximates a sphere, and because lines of longitude converge as one moves north or south from the equator, the formulae used by the Census Bureau takes this convergence into account. The center of population, as calculated by the Census Bureau can be expressed as:

$$\bar{\lambda} = \frac{\sum w_i \lambda_i \cos(\phi_i)}{\sum w_i \cos(\phi_i)} \quad \bar{\phi} = \frac{\sum w_i \phi_i}{\sum w_i}$$

where λ_i is longitude, ϕ_i is latitude, and w_i is population for each point used in the calculation. The cosign of the latitude ($\cos(\phi_i)$) is used to account for the convergence of lines of longitude as one moves north from the equator.

Most local governments, Bloomington included, work with spatial data in the State Plane coordinate system. This coordinate system is more appropriate for the large scale (think small areas) applications common at the city and county levels. While latitude and longitude are measured in decimal degrees or degrees/minutes/seconds, State Plane x, y coordinates are measured in feet or meters. The City of Bloomington GIS Group measures x, y coordinates in feet. State Plane is a Cartesian coordinate system and as such there is no convergence of x as y increases (as one moves north). Thus, the formulae used to calculate the center of population for the city of Bloomington has been adapted from the U.S. Census Bureau formulae expressed above. The cosign of ϕ_i (the y coordinate) has been omitted so that center of population is expressed as:

$$\bar{\lambda} = \frac{\sum w_i \lambda_i}{\sum w_i} \quad \bar{\phi} = \frac{\sum w_i \phi_i}{\sum w_i}$$

where λ_i is the x coordinate, ϕ_i is the y coordinate, and w_i is population for each of the 955 points used in the calculation.

Results of the Calculation

The x, y coordinate that resulted from the above calculation and that represents the center of population for Bloomington, Indiana is 3111221.262, 1424934.006. The coordinate is expressed in State Plane coordinates with feet as the coordinate unit of measure. The geographic information system software was used to convert the coordinate to longitude, latitude. In decimal degrees, the center of population is approximately 86.524° West and 39.159° North. In degrees/minutes/seconds, the center of population is approximately 86° 31' 28.094" West and 39° 9' 33.197" North.

References

Bureau of the Census, *Centers of Population Computation for 1950, 1960, 1970, 1980, 1990, and 2000*. U.S. Department of Commerce, Bureau of the Census, Washington, DC, April 2001.